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SUPPLEMENTARY TESTS ON THE EFFECTS OF HEATING AND COOLING A CIRCULATE ENVELOPE

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to
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SUPPLEMENTARY TESTS ON THE EFFECTS OF HEATING AND COOLING A GILSULATE ENVELOPE

by

Selden D. Cole and Paul R. Achenbach

1. INTRODUCTION

In response to the request of the Office of The Chief of Engineers, Department of the Army, an investigation was made of the mineral Gilsonite as an insulating material for underground steam pipes operating at a pressure of 125 psig corresponding to a saturation temperature of 350F. The results of that investigation were transmitted to the Office of the Chief of Engineers in a National Bureau of Standards Report No. 4231.

This report summarizes additional information, obtained after the first investigation, as a verification of the effect of cyclic heating and cooling on a Gilsulate envelope.

2. TEST EQUIPMENT

Loose Type B Gilsulate from the same supply of material furnished for the earlier tests was poured around a one inch black iron pipe centered lengthwise in a 9"x9"x24" box of cement-asbestos board. A copper-constantan thermocouple of no. 24 wire was peened into the pipe about three inches from the outlet end of the box, and a pressure gage was attached to the line downstream from the thermocouple and ahead of a cut-off valve. The other end of the pipe was connected to a source of steam.

SUPPLEMENTARY TESTS ON THE EFFECTS OF HEATING AND COOLING A DILSULATE MANELOPE

by

Selden D. Cole and Paul R. Achenbach

I. INTRODUCTION

In response to the request of the Office of The Chief of Engineers, Department of the Army, an investigation was made of the mineral dilsonite as an insulating material for underground steam pipes operating at a pressure of 125 psig corresponding to a saturation temperature of 352F. The results of that investigation were transmitted to the Office of the Chief of Engineers in a National Bureau of Standards Report No. 1231.

This report summarizes additional information, obtained after the first investigation, as a verification of the effect of cyclic heating and cooling on a dilsulate envelope.

2. TEST EQUIPMENT

Loose Type B dilsulate from the same supply of material furnished for the earlier tests was poured around a one inch black iron pipe centered lengthwise in a 9"x9"x24" box of cement-asbestos board. A copper-constantan thermocouple of no. 24 wire was peened into the pipe about three inches from the outlet end of the box, and a pressure gage was attached to the line downstream from the thermocouple and ahead of a cut-off valve. The other end of the pipe was connected to a source of steam.

3. PROCEDURE AND RESULTS

Steam at 377F, as measured with the installed thermocouple, was passed through the pipe embedded in the loose Gilsulate for 4 1/2 hours to provide initial consolidation. At the end of the 4 1/2 hours, an examination of a small section of pipe and insulation at the outlet end showed a very thin consolidated liquid-like layer adhering to the pipe and about one inch thickness of material sintered loosely together. The steam was turned off and the system allowed to cool down normally to room temperature. A series of heating and cooling cycles with steam at a temperature of 350F followed the initial heating at 377F, with an occasional inspection of the consolidated core being made near the outlet end of the pipe just before the end of the heating period.

CYCLE	HEATING PERIOD, HR	PERIOD WITHOUT HEAT, HR	INSPECTION
1	5.5	18.5	Yes
2	6.5	17.5	No
3	6.0	18.0	No
4	127.0	41.0	Yes
5	5.0	163	No
6	5.0	19	No
7	7.0	17	No
8	5.5	18.5	No
9	30.0	18.0	No
10	5.5	-	Yes

The inspection following cycle 1 showed a softening of the sintered part of the core to a sponge-like consistency with a thin soft viscous consolidated layer near the pipe.

3. PROCEDURE AND RESULTS

Steam at 377°F, as measured with the installed thermocouple, was passed through the pipe embedded in the loose oilsand for 1 1/2 hours to provide initial consolidation. At the end of the 1 1/2 hours, an examination of a small section of pipe and insulation at the outlet end showed a very thin consolidated liquid-like layer adhering to the pipe and about one inch thickness of material sintered loosely together. The steam was turned off and the system allowed to cool down normally to room temperature. A series of heating and cooling cycles with steam at a temperature of 350F followed the initial heating at 377°F, with an occasional inspection of the consolidated core being made near the outlet end of the pipe just before the end of the heating period.

CYCLE	HEATING PERIOD, HR	PERIOD WITHOUT HEAT, HR	INSPECTION
1	5.5	16.5	Yes
2	6.5	17.5	No
3	6.0	18.0	No
4	127.0	41.0	Yes
5	5.0	19	No
6	5.0	19	No
7	7.0	17	No
8	5.5	18.5	No
9	30.0	18.0	No
10	5.5	-	Yes

The inspection following cycle 1 showed a softening of the sintered part of the core to a sponge-like consistency with a thin soft viscous consolidated layer near the pipe.

The inspection during cycle 4 was in two parts; (1) inspection after 60 hours of heating, showed a harder sintered core, with less viscous material at the pipe and more solid consolidation than before, and (2) at the end of 127 hours inspection showed some viscous material at the bottom of the pipe with none on the top half and an increase in the average size of the sintered core.

The inspection after cycle 10 is illustrated with Fig. 1 and Fig. 2. Fig. 1 shows the sintered core after the removal of the unconsolidated material and reveals a large longitudinal crack on the top. Fig. 2 shows that the sintered material came off the top half in well-defined pieces of coke-like material and with no adhesion to the pipe. The lower half of the core consisted of a sintered outside layer and an inner layer of a stiff gummy consolidated material adhering to the pipe. The adhesion can be seen below the center line of the pipe in Fig. 2.

4. CONCLUSION

Repeated heating and cooling of the Gilsulate conduit for a cumulative heating period of 203 hours showed different results at the top and bottom of the pipe. The top half showed numerous thin cracks that did not heal upon reheating. The inside surface was hard and free from the pipe. The lower half of the core adhered to the pipe after 203 hours of heating with some of the consolidated layer being softened

The inspection during cycle 1 was in two parts; (1) inspection after 60 hours of heating, showed a harder sintered core, with less vitreous material at the pipe and more solid consolidation than before, and (2) at the end of 127 hours inspection showed some vitreous material at the bottom of the pipe with none on the top half and an increase in the average size of the sintered core.

The inspection after cycle 10 is illustrated with Fig. 1 and Fig. 2. Fig. 1 shows the sintered core after the removal of the unconsolidated material and reveals a large longitudinal crack on the top. Fig. 2 shows that the sintered material came off the top half in well-defined pieces of coke-like material and with no adhesion to the pipe. The lower half of the core consisted of a sintered outside layer and an inner layer of a stiff gummy consolidated material adhering to the pipe. The adhesion can be seen below the center line of the pipe in Fig. 2.

4. CONCLUSION

Repeated heating and cooling of the bituminite conduit for a cumulative heating period of 203 hours showed different results at the top and bottom of the pipe. The top half showed numerous thin cracks that did not heal upon reheating. The inside surface was hard and free from the pipe. The lower half of the core adhered to the pipe after 203 hours of heating with some of the consolidated layer being softened

to a gummy viscous consistency at a pipe temperature of 350°F. The cracking of the envelope and the fracture of the material into coke-like lumps was similar to that reported for the earlier investigations.

FIG. 1

FIG. 2